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Neoechinorhynchus rostratum sp. n. (Acanthocephala: Neoechinorhynchidae) from the Eel, *Anguilla rostrata,* in Estuarine Waters of Northeastern North America

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ABSTRACT: *Neoechinorhynchus rostratum* sp. n. (Neoechinorhynchidae) is described from the eel, *Anguilla rostrata* (Le Sueur), in estuarine waters along the New England and Canadian coasts. The new species is very similar to *N. cylindratus* (Van Cleave, 1913) Van Cleave 1919 with which it has been taxonomically confused. The 2 species can, however, be separated based on egg morphology and the shape of the adult female posterior end, among other features such as host and habitat distribution. Museum specimens of *N. cylindratus* from eels have been examined and reassigned to the new species.

KEY WORDS: Acanthocephala, *Neoechinorhynchus rostratum* sp. n., Neoechinorhynchidae, *Anguilla rostrata,* north Atlantic coast of North America.

Van Cleave (1913) originally described *Neoechinorhynchus cylindratus* based on 41 mature adults from largemouth bass, *Micropterus salmoides* (Lacépède), in Minnesota. He (Van Cleave, 1913, 1919) also indicated that the eel, *Anguilla rostrata* (Le Sueur), was an additional host of the same acanthocephalan species based on material received from Linton identified by him (Linton) as *Echinorhynchus agilis* from eels collected near Woods Hole, Massachusetts. All *Neoechinorhynchus* Hamann, 1892 in Stiles and Hassall, 1905 material found in eels has been routinely classified as *N. cylindratus* since. Bullock (1970) suggested the possibility that specimens from eels may represent a new species of *Neoechinorhynchus.* The recent availability of Bullock's collections of "*Neoechinorhynchus cylindratus*" from the eel verified Bullock's earlier suggestion (see Amin, 1998), and these specimens are herein described as a new species.

Materials and Methods

Acanthocephalans were recovered from eels, *Anguilla rostrata,* in the Oyster River and Johnson Creek in Durham, Stafford County, and in Newington, Rockingham County, New Hampshire. Forty-seven ethanol-preserved worms collected between June and August in 1974 and 1975 were stained in Mayer's acid carmine, dehydrated in ascending concentrations of ethanol, cleared in graduated concentrations of terpineol in 100% ethanol, and whole mounted in Canada balsam.

Other specimens from eels studied include those of Linton from Woods Hole, Massachusetts, and Van Cleave from Baltimore, Maryland, and other unspecified North American locations and from River Denys, Nova Scotia, Canada. Specimens from mummichog, *Fundulus heteroclitus* (Linnaeus), in Salisbury Cove, Maine and Woods Hole, Massachusetts, and from needle fish, *Strongylura marina* (Wallbaum), in Woods Hole were also examined. All above material was identified as "*N. cylindratus*" by Van Cleave or Linton (the latter 2 collections). These specimens were made available from the United States National Parasite Collection (USNPC), Beltsville, Maryland. Other specimens collected from the same and other host species, e.g., Atlantic tomcod, *Microgadus tomcod,* (Walbaum), and grubby, *Myoxocephalus aeneus,* (Mitchill), are available from the Harold W. Manter Laboratory, Nebraska State Museum, Lincoln, Nebraska. For comparative purposes, many *N. cylindratus* from *M. salmoides* in Wisconsin (Amin, 1986a, b) were also studied.

Specimens measured include ours from New Hampshire (10 males, 16 females) and a few of the USNPC specimens that were sufficiently informative (3 males, 5 females). Measurements are in micrometers unless otherwise stated. The range is followed by mean values (in parentheses). Width measurements refer to maximum width. Body (=trunk) length does not include neck, proboscis, or male bursa. Eggs refer to fully developed ripe eggs measured in situ through the body wall of females.

Results

Neoechinorhyncus rostratum sp. n. (Figs. 1–6)

Description

GENERAL: Neoechinorhynchidae, Neoechinorhynchinae with characters of the genus. Shared structures larger in females than in males. Trunk cylindrical and widest in anterior half, normally with 5 dorsal and 1 ventral giant nuclei (Figs. 1, 2).

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Proboscis with prominent apical structure, wider than long, with large hooks in anterior ring heavily rooted and with hooks in posterior ring not much smaller than those of middle ring. Proboscis receptacle single walled, about 3 times as long as proboscis, with brain at its posterior end (Fig. 4). Lemnisci subequal, considerably longer than proboscis receptacle (Figs. 1, 2). Gonopore nearly terminal in both sexes in juveniles and adults (Figs. 1, 2, 5).

MALES (based on 13 specimens with sperm): See Table 1 for measurements. Reproductive system in posterior half of trunk. Anterior testis larger than and contiguous to posterior testis. Cement reservoir 140–343 (297) long by 102–241 (148) wide, marginally overlaps cement gland posteriorly and with 2 main cement ducts (Fig. 1).

FEMALES (based on 21 specimens gravid with eggs and/or ovarian balls): See Table 1 for measurements. Reproductive system 356–826 (629) long in 11 individuals measuring 2.902–8.424 (6.521) mm long (9.6% of trunk length) (Table 2); uterus markedly longer than uterine bell (Fig. 5). Ripe eggs fusiform with polar prolongation of fertilization membrane (Fig. 6).

Taxonomic summary

TYPE HOST: *Anguilla rostrata* (Le Sueur) (Anguillidae).

OTHER HOSTS: *Fundulus heteroclitus* (Linnaeus) (Cyprinodontidae), mostly juveniles in liver; *Strongylura marina* (Wallbaum) (Belonidae), in intestine; *Microgadus tomcod* (Gadidae), immatures in intestine; *Myoxocephalus aeneus* (Cottidae), immatures in intestine.

SITE OF INFECTION: Intestine.

TYPE LOCALITY: Oyster River, Durham, Stafford County, New Hampshire.

OTHER LOCALITIES: Numerous estuarine sites along east coast of North America between Baltimore, Maryland, and Nova Scotia, Canada.

ETYMOLOGY: The new species is named for the specific name of the definitive host.

SPECIMENS DEPOSITED: USNPC No. 87297 (holotype male); No. 87298 (allotype female); No. 87299 (paratypes).

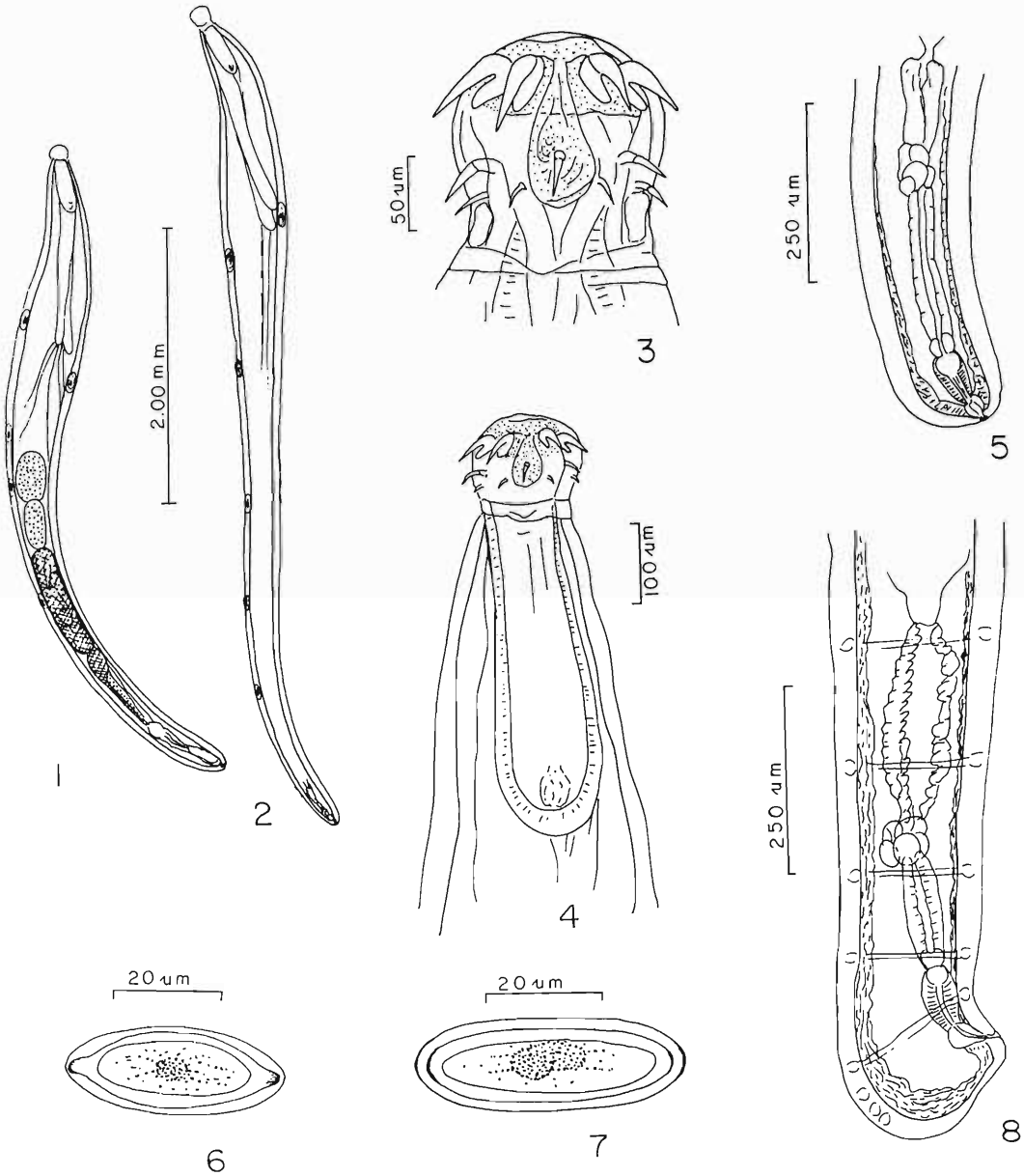
OTHER SPECIMENS EXAMINED: USNPC Nos. 6350, 7629, 38589, 64810, 64812, 64815 from eel, Nos. 64813, 35890 from *F. heteroclitus,* and No. 38591 from *S. marina,* all of which were identified as *N. cylindratus* mostly by Van Cleave; as well as many *N. cylindratus* from the Amin collection from *M. salmoides* in Wisconsin.

Remarks

Neoechinorhynchus rostratum is so similar to *N. cylindratus* that it has been routinely confused with it since Van Cleave's (1913, 1919, 1921) earliest reports of it from eel. Van Cleave's (1921) few measurements of the eel specimens were almost identical to those from *M. salmoides,* upon which he based his original description of *N. cylindratus* (Van Cleave, 1913).

Epidemiologically, *N. rostratum* is an estuarine parasite that matures in the eel. Only immature specimens have been found in the intestine of tomcod, *M. tomcod,* and grubby, *M. aeneus,* in the same localities as infected eels. Liver infections with juveniles in *F. heteroclitus* are occasionally numerous as reported by Manter (1926), who showed that mummichog may serve as a transport host for *N. rostratum* in Mount Desert Island, Maine. The use of transport hosts represents another similarity between *N. cylindratus* and *N. rostratum.* The only infections of the new species in a freshwater centrarchid, normal hosts for *N. cylindratus,* were found in pumpkin seed, *Lepomis gibbosus* collected on numerous occasions from 1 small freshwater pond. This pond was close to the Great Bay, New Hampshire, estuary and emptied into Carter's Brook, a tidal creek. Infected eels and *Fundulus* were common in the same pond. No other infections with *Neoechinorhynchus* were ever found upon the examination of hundreds of *Lepomis* from numerous other localities in New Hampshire. One attempt was made to infect a smallmouth black bass, *Micropterus dolomieui,* by feeding it on *Fundulus* over a 6-mo period. The result was a heavy infection of only immature *Neoechinorhynchus.*

Morphologically, 4 major characteristics separate the 2 species. (1) The ripe egg of *N. rostratum* is somewhat fusiform with polar prolongation of fertilization membrane (Fig. 6). The ripe egg of *N. cylindratus* is longer, oblong, with concentric membranes and no prolongation (Fig. 7). (2) The posterior end of *N. rostratum* females of all stages of growth is almost blunted with a near terminal gonopore (Fig. 5). In *N. cylindratus* juvenile females, the posterior end is similar, but in the maturing adult, the near terminal gonopore begins to develop a distinct body wall pro-



Figures 1–8. Figures 1–6. *Neoechinorhynchus rostratum* sp. n. from *Anguilla rostrata* 1. Holotype male. 2. Allotype female. 3. Proboscis of holotype male. 4. Proboscis and proboscis receptacle of holotype male (lateral view). 5. Reproductive system and posterior end of a paratype female. 6. Ripe egg from the body cavity of a paratype female. Figures 7, 8. *Neoechinorhynchus cylindratus* from *Micropterus salmoides*. 7. Ripe egg from the body cavity of a female. 8. Reproductive system and posterior end of a female.

trusion as it becomes displaced ventrally. This protrusion becomes associated with the development of a well-pronounced posteriorly rounded swelling (Fig. 8). A mass of well-developed muscles lines the swelling internally and connects to the vagina. Adult *N. rostratum* females retain the juvenile form, and no such displacement of gonopore, swelling, or extensive muscle development occurs in mature *N. rostratum*. Similar changes and gonopore displacement be-

Table 1. Morphometric characteristics of adult *Neoechinorhynchus cylindratus* and *N. rostratum*.

		Neoechinorhynchus cylindratus			*Neoechinorhynchus rostratum*	
Reference		Van Cleave (1913, 1919, 1921)	Ward (1940)	Amin (1986a, b)	Van Cleave (1921)	This paper
Host		*Micropterus salmoides*	*Micropterus salmoides*	*Micropterus salmoides*	*Anguilla rostrata*	*Anguilla rostrata*
Locality		Minnesota	Indiana	Wisconsin	Massachusetts	New England
n		41 F, M	22 F, 14 M	150 F, 199 M	?	21 F, 13 M
Females						
Trunk	Length	10.0–15.0	7.0–11	2.32–17.40 (9.7)*	—	2.90–13.01 (7.31)
(mm)	Width	0.7	0.35–0.70	0.28–0.84 (0.54)	—	0.31–0.8 (0.60)
Proboscis	Length	149	100–140	106–160 (140)	150	127–178 (150)
	Width	172	160–190	125–208 (176)	172	140–216 (174)
Hooks	Ant	79–97	61–88	58–109 (91)	79–97	74–93 (82)
	Mid	37	24–40	26–42 (37)	37	38–48 (44)
	Post	21–25	17–27	16–35 (28)	21–25	32–41 (37)
Prob rec	Length	ca. 450	280–350	140–560 (428)	—	317–559 (428)
	Width	—	110–150	56–196 (160)	—	114–190 (155)
Lemnisci	Long	—	950–1,400	378–2,352 (1,378)	—	978–2,146 (1,520)
	Short	—	850–1,340	294–2,044 (1,242)	—	762–1,854 (1,327)
Eggs	Length	49–51	51–61	32–64 (48)	49–51	32–45 (39)
	Width	15–21	17–28	13–25 (17)	15–21	13–22 (17)
Males						
Trunk	Length	4.5–8.5	4.7–6.3	1.84–11.36 (6.66)	—	2.90–7.18 (4.59)
(mm)	Width	0.5–0.7	0.36–0.63	0.28–0.76 (0.52)	—	0.31–0.75 (0.48)
Prob	Length	149	100–140	86–150 (136)	150	114–152 (137)
	Width	172	150–170	112–189 (165)	172	127–178 (155)
Hooks	Ant	79–97	58–82	51–102 (86)	79–97	74–83 (77)
	Mid	37	24–34	22–45 (36)	37	42–48 (45)
	Post	21–25	17–24	16–32 (26)	21–25	32–32 (32)
Prob rec	Length	ca. 450	240–350	140–504 (398)	—	229–483 (399)
	Width	—	130–140	56–252 (144)	—	114–178 (151)
Lemnisci	Long	—	840–1,200	378–1,792 (1,109)	—	965–1,905 (1,375)
	Short	—	740–1,050	322–1,792 (1,020)	—	900–1,333 (1,223)
Ant testis	Length	700	400–700	224–1,722 (690)	—	317–635 (475)
	Width	260	180–250	112–350 (228)	—	140–381 (222)
Post testis	Length	smaller	210–550	140–1,372 (607)	—	317–749 (466)
	Width	—	170–270	98–378 (226)	—	140–267 (201)
Cement gl	Length	1.050 mm	670–1,200	196–2,184 (1,057)	—	470–1,651 (741)
	Width	—	130–280	98–350 (195)	—	140–292 (182)

* Range (mean).

Table 2. Comparison between the measurements of the reproductive system of female *Neoechinorhynchus cylindratus and *N. rostratum*.**

	Trunk length (TL) mm	Reproductive system length (RSL) mm	RSL/TL %
N. rostratum (n = 11)	2.902–8.424 (6.521)†	0.356–0.826 (0.629)	9.6
N. cylindratus (n = 8)	5.772–8.424 (6.486)	0.394–0.737 (0.587)	9.1
N. cylindratus (n = 9)	9.672–16.538 (13.295)	0.698–1.270 (0.980)	7.4
N. cylindratus (total, n = 17)	5.772–16.538 (10.090)	0.394–1.270 (0.795)	7.9

* From Wisconsin *M. salmoides* (Amin, 1986a, b).
† Range (mean).

tween juvenile and adult acanthocephalans are also known in other species of *Neoechinorhynchus,* e.g., *N. idahoensis* Amin and Heckmann 1992. (3) The female reproductive system is of similar length and proportion to trunk length in worms of comparable body length of both species (Table 2). However, the uterus is markedly longer than uterine bell in *N. rostratum* (Fig. 5); the opposite is true in *N. cylindratus* (Fig. 8). (4) Morphometric differences are minimal, except for the relatively longer proboscis hooks in middle and posterior rings and the shorter testes and cement gland of *N. rostratum* compared to *N. cylindratus* (Table 1).

The very close similarities, as well as differences, between *N. rostratum* and *N. cylindratus* are well documented. However, the uniquely fusiform egg with polar prolongation in the first species brings *N. rostratum* closer to species of the genus *Hebesoma* (Van Cleave 1928), which is primarily separated from most *Neoechinorhynchus* spp. based on its egg structure. Other species of *Neoechinorhyncus* with fusiform eggs and/or polar prolongation include *N. agilis* (Rudolphi, 1819) Van Cleave, 1916, *N. doryphorus* Van Cleave and Bangham, 1949, *N. chrysemydis* Cable and Hopp, 1954, and *N. lingulatus* Nickol and Ernst, 1987. *Neoechinorynchus rostratum* may be separated from these other 4 species of *Neoechinorynchus* as follows: anterior proboscis hooks of *N. agilis* are larger (84–140 long); those of *N. doryphorus* are unequal in size; the 2 laterals are conspicuously larger (105–132 long) compared to others in the same circle (61–72 long); the lateral anterior proboscis hooks of *N. chrysemydis* are also larger (80–140 long) than others in the same circle (48–82 long), and eggs are larger (55–60 by 19–22); the proboscis of *N. lingulatus* is considerably larger (192–240 long by 197–254 wide) than in *N. rostratum,* and the lateral hooks of its anterior circle are longer (106–125) than others in the same circle (82–110 long) and set distinctly posterior to them. The latter 2 species are parasitic in turtles; female worms in both species have a prominent papilla/process near their subterminal gonopore. More careful study of *Hebesoma* may show it to be much more closely related to *Neoechinorhynchus* than previously thought.

The above findings shed some light on host and environmental segregation of the 2 species of *Neoechinorhynchus* that are morphologically so similar and raise interesting questions on the speciation in the genus.

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